

## ANNUAL SUMMARY FOR 1888.

Two additional charts (numbers viii and ix) are published with this issue of the REVIEW showing, respectively, the annual isotherms and departures from the normal temperature, and the annual precipitation for 1888.

## TEMPERATURE.

The annual mean temperature was highest over southern Florida, where the readings ranged above 75°. Over Florida south of the twenty-ninth parallel, and in the lower Rio Grande and lower Colorado valleys, the mean temperature was above 70°. In the southern states south of the thirty-fifth parallel and east of the ninety-fifth meridian, a greater portion of Texas, southern New Mexico, and southern Arizona, and the southern half and north-central part of California, the values rose above 60°. The mean temperature was lowest in the lower Saint Lawrence valley, over the northern part of Lake Superior, Manitoba, northern Minnesota, and northern Dakota, where it fell below 35°. It was below 40° north of the forty-fifth parallel, except in the Rocky Mountain regions and on the Pacific coast, where it increased gradually to nearly 55° in Oregon. Over the middle plateau region of the Rocky Mountains, within a limited area embracing central and northwestern Nevada, and adjacent portions of California and Oregon, the mean temperature fell below 50°.

The annual mean temperature corresponded with the normal along a line traced irregularly southward from Montana to western Texas; at stations in Manitoba, the lower Mississippi valley, southwestern New England, along the west coast of the Gulf of Saint Lawrence, and along a line inclosing an area extending from Pennsylvania south-southwest to north-central Florida. The means were above the normal in the Rocky Mountain regions and on the Pacific coast. Over the eastern and central portions of the country the year was colder than the average, save in the localities above referred to in which normal temperatures were noted, where small excesses were reported.

The departures above the normal were most marked over the middle and northern plateau regions of the Rocky Mountains, and along a considerable portion of the Pacific coast, where they generally ranged between one and two degrees. The departures below the normal were greatest in portions of the upper lake region and upper Mississippi valley, over the eastern end of Lake Ontario, and at stations on the New England coast, where they, in instances, exceeded three degrees.

The following are some of the most marked departures from the normal at the older established Signal Service stations:

| Above normal.        |     | Below normal.      |     |
|----------------------|-----|--------------------|-----|
| Salt Lake City, Utah | 1.9 | Portland, Me.      | 3.8 |
| Roseburg, Oregon     | 1.9 | Oswego, N. Y.      | 3.2 |
| Spokane Falls, Wash. | 1.6 | La Crosse, Wis.    | 3.0 |
| New Haven, Conn.     | 1.6 | Saint Paul, Minn.  | 2.8 |
| Red Bluff, Cal.      | 1.5 | Detroit, Mich.     | 2.7 |
| Pittsburgh, Pa.      | 1.5 | Grand Haven, Mich. | 2.5 |

## PRECIPITATION.

The greatest amount of precipitation for the year was reported at Neah Bay, Makah Indian Reservation, in the extreme northwest part of Washington, where a total of 102.97 inches fell. Along and near the coasts of the middle Gulf states the rainfall exceeded 70 inches, and at New Orleans, La., it amounted to 83.1 inches. On the Atlantic coast the rainfall was heaviest over the western part of Nova Scotia, where it amounted to 67.9 at Yarmouth, N. S., at stations in New England, in the south Atlantic states, and on the east-central coast of Florida, where it exceeded 50 inches. From the Atlantic and Gulf coasts the amount of rainfall decreased gradually, though somewhat irregularly, to the Rocky Mountain regions, where in the middle districts it generally fell below 10 inches. The rainfall was also less than 10 inches along the southern border from the western extremity of Texas to southern California, and in east-central California. On the Pacific coast there was a gradual decrease in the amount of

rainfall reported from Washington southward to southern California, where it amounted to 11.6 inches at San Diego.

As compared with the annual normal the excesses and deficiencies in precipitation for 1888 were irregularly distributed over the country. Among the more remarkable features may be noted the large deficiency in rainfall at Block Island, R. I. At this station the precipitation was 24 inches less than the average for previous years, while at New Haven, Conn., Portland, Me., and Yarmouth, N. S., the excesses were, respectively, 11.3, 18.1, and 21.3 inches. Deficiencies exceeding 10 inches were also reported at Portland, Oregon, Tatoosh Island, Wash., Hatteras, N. C., Moorhead, Minn., Cedar Keys, Fla., Omaha, Nebr., and at Vicksburg, Miss. The most marked excesses in precipitation, other than those above noted, occurred along the middle and a portion of the west Gulf coast, where they were more than 10 inches, the greatest, 19.3, occurring at New Orleans, La.; at Fort Smith, Ind. T., and Fort Maginnis, Mont., the yearly precipitation exceeded the average by 10.4 and 10.2 inches, respectively. Over the plateau and Pacific coast regions the rainfall was deficient, except over the southern half of California, southern Nevada, and northern and western Arizona, where there was a slight excess.

The following table gives annual summaries of temperature and precipitation observations at the older established Signal Service stations during 1888, together with the departures from the annual normals:

| Stations and districts.        | Temperature—degrees Fahrenheit. |                        |                    |                       |       |              | Precipitation in inches. |                        |                       |
|--------------------------------|---------------------------------|------------------------|--------------------|-----------------------|-------|--------------|--------------------------|------------------------|-----------------------|
|                                | Mean for 1888.                  | Departure from normal. | Extremes for 1888. |                       |       |              | Total for 1888.          | Departure from normal. | Percentage of normal. |
|                                |                                 |                        | Max.               | Date of max.          | Min.  | Date of min. |                          |                        |                       |
| <i>New England.</i>            |                                 |                        |                    |                       |       |              |                          |                        |                       |
| Eastport.....                  | 40.2                            | —1.4                   | 88.0               | June 23               | —12.2 | Jan. 25      | 53.2                     | +2.8                   | 106                   |
| Portland.....                  | 42.8                            | —3.8                   | 96.5               | June 23               | —12.3 | Jan. 29      | 59.2                     | +18.1                  | 144                   |
| Manchester.....                | 44.2                            | —1.3                   | 96.3               | June 23               | —11.0 | Feb. 10      | 46.8                     | .....                  | .....                 |
| Northfield.....                | 39.5                            | .....                  | 89.2               | June 23               | —24.1 | Jan. 25      | 45.9                     | .....                  | .....                 |
| Boston.....                    | 47.3                            | —1.5                   | 96.2               | June 23               | —6.2  | Jan. 29      | 45.9                     | —1.0                   | 98                    |
| Nantucket.....                 | 47.5                            | .....                  | 81.0               | Aug. 3-19             | —3.5  | Jan. 29      | 45.7                     | +8.4                   | 122                   |
| Wood's Hole.....               | 46.6                            | .....                  | 79.0               | Aug. 3-4              | —3.9  | Jan. 29      | 49.4                     | .....                  | .....                 |
| Block Island.....              | 46.9                            | —2.6                   | 82.6               | June 23               | —3.0  | Jan. 22      | 27.2                     | —24.0                  | 53                    |
| New Haven.....                 | 47.4                            | +1.6                   | 94.1               | June 23               | —4.4  | Jan. 22      | 60.3                     | +11.3                  | 123                   |
| New London.....                | 48.6                            | —0.8                   | 91.8               | June 23               | —3.0  | Jan. 22      | 45.6                     | —3.7                   | 92                    |
| <i>Middle Atlantic states.</i> |                                 |                        |                    |                       |       |              |                          |                        |                       |
| Albany.....                    | 46.1                            | —2.9                   | 96.2               | June 23               | —10.0 | Feb. 10      | 44.7                     | +7.0                   | 119                   |
| New York City.....             | 51.4                            | —0.6                   | 96.3               | Aug. 16               | —1.9  | Jan. 22      | 53.0                     | +9.1                   | 121                   |
| Philadelphia.....              | 52.8                            | —1.3                   | 97.8               | Aug. 8                | —2.4  | Jan. 22      | 44.1                     | +3.7                   | 109                   |
| Atlantic City.....             | 50.8                            | —1.6                   | 91.0               | July 7                | —2.5  | Jan. 22      | 44.1                     | +1.5                   | 104                   |
| Baltimore.....                 | 53.8                            | —1.8                   | 95.8               | Aug. 16               | —9.2  | Jan. 22      | 43.5                     | +0.4                   | 101                   |
| Washington City.....           | 53.8                            | —1.3                   | 97.2               | Aug. 8                | —9.2  | Jan. 28      | 45.0                     | +1.2                   | 103                   |
| Norfolk.....                   | 58.4                            | —1.1                   | 98.4               | Aug. 8                | —14.1 | Mar. 14      | 56.6                     | +5.5                   | 111                   |
| <i>South Atlantic states.</i>  |                                 |                        |                    |                       |       |              |                          |                        |                       |
| Charlotte.....                 | 60.6                            | +0.3                   | 100.0              | Aug. 7                | 15.5  | Feb. 28      | 52.6                     | —2.9                   | 95                    |
| Hatteras.....                  | 60.7                            | —0.7                   | 87.8               | Aug. 9                | 22.5  | Jan. 28      | 56.7                     | —14.3                  | 80                    |
| Raleigh.....                   | 59.0                            | .....                  | 101.0              | July 12               | 15.0  | Feb. 28      | 56.9                     | .....                  | .....                 |
| Wilmington.....                | 62.6                            | —1.0                   | 95.9               | July 12               | 20.0  | Jan. 19      | 55.1                     | —2.4                   | 96                    |
| Charleston.....                | 65.8                            | —0.5                   | 100.2              | July 13               | 26.0  | Jan. 19      | 49.5                     | —8.6                   | 85                    |
| Columbia.....                  | 63.2                            | .....                  | 100.6              | July 12               | 21.3  | Jan. 19      | 47.9                     | .....                  | .....                 |
| Augusta.....                   | 64.6                            | —0.4                   | 103.8              | July 8                | 22.0  | Feb. 28      | 49.9                     | +4.8                   | 111                   |
| Savannah.....                  | 66.4                            | —0.7                   | 99.0               | July 8                | 25.0  | Dec. 21      | 47.1                     | —5.8                   | 89                    |
| Jacksonville.....              | 69.5                            | —0.4                   | 98.4               | July 13               | 27.5  | Jan. 19      | 53.1                     | —4.1                   | 93                    |
| <i>Florida peninsula.</i>      |                                 |                        |                    |                       |       |              |                          |                        |                       |
| Titusville.....                | 70.6                            | .....                  | 95.0               | July 13               | 32.0  | Dec. 21      | 60.0                     | .....                  | .....                 |
| Cedar Keys.....                | 70.4                            | 0.0                    | 91.0               | Sept. 4               | 29.3  | Jan. 19      | 43.1                     | —12.4                  | 78                    |
| Key West.....                  | 76.8                            | —1.1                   | 91.0               | Aug. 4                | 51.6  | Dec. 21      | 35.6                     | —3.8                   | 90                    |
| Jupiter.....                   | 78.6                            | .....                  | 94.0               | July 12               | 36.4  | Dec. 22      | 52.4                     | .....                  | .....                 |
| <i>East Gulf states.</i>       |                                 |                        |                    |                       |       |              |                          |                        |                       |
| Atlanta.....                   | 61.1                            | 0.0                    | 95.7               | Aug. 7                | 13.0  | Feb. 28      | 65.0                     | +9.9                   | 118                   |
| Pensacola.....                 | 67.8                            | —0.3                   | 94.0               | July 14               | 26.1  | Jan. 19      | 61.9                     | —3.3                   | 95                    |
| Mobile.....                    | 66.8                            | —0.7                   | 96.6               | July 14               | 23.0  | Jan. 19      | 75.6                     | +11.4                  | 118                   |
| Montgomery.....                | 65.6                            | —0.3                   | 97.6               | July 14               | 17.5  | Jan. 19      | 61.4                     | +8.1                   | 115                   |
| Vicksburg.....                 | 65.4                            | —0.6                   | 97.0               | July 14               | 17.5  | Jan. 16      | 48.5                     | —10.9                  | 82                    |
| New Orleans.....               | 69.2                            | —0.2                   | 96.5               | July 15               | 28.8  | Jan. 19      | 83.1                     | +19.3                  | 130                   |
| <i>West Gulf states.</i>       |                                 |                        |                    |                       |       |              |                          |                        |                       |
| Shreveport.....                | 65.2                            | —1.2                   | 98.5               | July 14               | 15.0  | Jan. 15      | 44.8                     | —9.2                   | 84                    |
| Fort Smith.....                | 60.5                            | —0.1                   | 100.0              | Aug. 1                | 1.2   | Jan. 15      | 51.0                     | +10.4                  | 126                   |
| Little Rock.....               | 61.0                            | —1.4                   | 97.3               | July 13               | 7.0   | Jan. 16      | 57.6                     | +4.6                   | 109                   |
| Corpus Christi.....            | 69.2                            | —1.0                   | 91.7               | Aug. 30               | 15.7  | Jan. 15      | 48.2                     | .....                  | .....                 |
| Galveston.....                 | 69.3                            | —0.9                   | 93.5               | Aug. 1                | 23.0  | Jan. 16      | 66.0                     | +14.3                  | 128                   |
| Palestine.....                 | 65.0                            | —0.6                   | 95.2               | Aug. 2                | 3.7   | Jan. 15      | 59.7                     | +8.1                   | 119                   |
| San Antonio.....               | 67.6                            | —0.9                   | 99.4               | Aug. 7                | 11.4  | Jan. 15      | 40.6                     | +10.1                  | 133                   |
| <i>Rio Grande Valley.</i>      |                                 |                        |                    |                       |       |              |                          |                        |                       |
| Rio Grande City.....           | 73.1                            | —1.2                   | 104.4              | Aug. 19               | 21.0  | Jan. 15      | 22.7                     | —1.1                   | 95                    |
| Brownsville.....               | 73.0                            | +0.2                   | 97.2               | Aug. 19               | 21.4  | Jan. 16      | 32.6                     | —4.8                   | 87                    |
| <i>Ohio Valley &amp; Tenn.</i> |                                 |                        |                    |                       |       |              |                          |                        |                       |
| Chattanooga.....               | 60.5                            | +0.1                   | 97.6               | Aug. 7                | 10.1  | Feb. 28      | 54.9                     | —3.5                   | 94                    |
| Knoxville.....                 | 58.4                            | 0.0                    | 96.0               | Aug. 3                | 9.1   | Feb. 28      | 53.0                     | —0.7                   | 99                    |
| Memphis.....                   | 60.8                            | +0.8                   | 98.9               | Aug. 2                | 6.2   | Jan. 16      | 46.8                     | —7.5                   | 86                    |
| Nashville.....                 | 58.6                            | —0.7                   | 98.0               | Aug. 3                | 2.0   | Jan. 16      | 50.5                     | —1.6                   | 97                    |
| Louisville.....                | 56.2                            | —1.1                   | 98.5               | { Aug. 19<br>June 1 } | 7.9   | Jan. 16      | 47.8                     | +0.1                   | 100                   |
| Indianapolis.....              | 51.6                            | —0.8                   | 97.5               | Aug. 2                | —6.0  | Jan. 16      | 41.4                     | —3.8                   | 92                    |
| Cincinnati.....                | 53.8                            | —1.7                   | 97.4               | Aug. 3                | 5.6   | Feb. 27      | 34.9                     | —7.0                   | 83                    |

## Annual summary of Signal Service observations—Continued.

| Stations and districts.         | Temperature—degrees Fahrenheit. |                        |                    |                        |       |              | Precipitation in inches. |                        |                       |
|---------------------------------|---------------------------------|------------------------|--------------------|------------------------|-------|--------------|--------------------------|------------------------|-----------------------|
|                                 | Mean for 1888.                  | Departure from normal. | Extremes for 1888. |                        |       |              | Total for 1888.          | Departure from normal. | Percentage of normal. |
|                                 |                                 |                        | Max.               | Date of max.           | Min.  | Date of min. |                          |                        |                       |
| Columbus                        | 51.0                            | -1.2                   | 97.4               | June 20                | 2.2   | Jan. 28      | 35.1                     | -5.9                   | 86                    |
| Pittsburgh                      | 51.8                            | +1.5                   | 95.2               | June 20                | 1.1   | Feb. 10      | 39.9                     | +2.9                   | 107                   |
| <i>Lower lake region.</i>       |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Buffalo                         | 44.8                            | -1.4                   | 86.0               | June 20                | -8.0  | Feb. 9-10    | 33.9                     | -4.1                   | 89                    |
| Oswego                          | 43.2                            | -3.2                   | 88.6               | July 4                 | -10.0 | Feb. 10      | 32.8                     | -2.0                   | 94                    |
| Rochester                       | 44.9                            | -1.8                   | 94.9               | June 23                | -8.0  | Feb. 10      | 27.8                     | -7.4                   | 82                    |
| Erie                            | 47.0                            | -1.9                   | 88.0               | Aug. 3                 | -8.0  | Feb. 10      | 31.9                     | -11.3                  | 74                    |
| Cleveland                       | 48.2                            | -0.4                   | 94.2               | Aug. 3                 | -3.1  | Feb. 10      | 32.6                     | -4.8                   | 87                    |
| Sandusky                        | 48.4                            | -1.6                   | 95.2               | Aug. 3                 | -3.0  | Feb. 15      | 26.4                     | -11.1                  | 70                    |
| Toledo                          | 47.6                            | -1.2                   | 95.0               | June 17                | -5.5  | Feb. 9       | 25.9                     | -6.8                   | 79                    |
| Detroit                         | 46.3                            | -2.7                   | 94.5               | June 17                | -7.0  | Feb. 15      | 29.0                     | -4.6                   | 86                    |
| <i>Upper lake region.</i>       |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Alpena                          | 39.6                            | -1.1                   | 90.0               | Aug. 3, 25             | -23.3 | Feb. 10      | 29.4                     | -8.5                   | 78                    |
| Grand Haven                     | 43.8                            | -2.5                   | 90.5               | June 18                | -7.0  | Feb. 9       | 26.0                     | -12.7                  | 67                    |
| Lansing                         | 44.8                            | -2.0                   | 95.8               | June 17, 20            | -11.8 | Feb. 9       | 27.1                     | -4.4                   | 86                    |
| Marquette                       | 37.9                            | -2.0                   | 93.6               | June 16                | -26.6 | Feb. 9       | 35.5                     | +2.9                   | 109                   |
| Port Huron                      | 44.0                            | -0.8                   | 93.0               | June 17                | -12.6 | Feb. 9       | 24.3                     | -9.2                   | 70                    |
| Chicago                         | 46.6                            | -2.1                   | 94.3               | July 31                | -17.5 | Jan. 21      | 30.9                     | -5.7                   | 82                    |
| Milwaukee                       | 43.4                            | -1.7                   | 90.8               | July 11                | -22.7 | Jan. 21      | 23.5                     | -9.9                   | 70                    |
| Green Bay                       | 41.2                            | -0.8                   | 92.0               | June 17                | -35.4 | Jan. 21      | 35.5                     | +2.9                   | 109                   |
| Duluth                          | 37.8                            | -0.8                   | 95.2               | Aug. 25                | -34.0 | Jan. 15      | 27.3                     | -4.5                   | 83                    |
| <i>Extreme Northwest.</i>       |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Moorehead                       | 36.6                            | -0.4                   | 98.0               | June 16                | -47.0 | Feb. 9       | 16.5                     | -10.4                  | 61                    |
| Saint Vincent                   | 33.2                            | -0.2                   | 96.3               | Aug. 23                | -53.5 | Jan. 11      | 17.2                     | +0.4                   | 102                   |
| Bismarck                        | 38.5                            | -1.0                   | 97.8               | Aug. 27                | -37.0 | Jan. 14      | 16.5                     | -3.3                   | 83                    |
| Fort Buford                     | 38.4                            | -1.4                   | 99.5               | June 18                | -49.2 | Jan. 9       | 14.7                     | +1.4                   | 103                   |
| Fort Totten                     | 34.8                            | -0.7                   | 94.2               | Aug. 23                | -41.5 | Feb. 9       | 16.1                     | -1.3                   | 93                    |
| <i>Up. Mississippi valley.</i>  |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Saint Paul                      | 41.2                            | -2.8                   | 94.0               | { July 11<br>Aug. 2 }  | -41.2 | Jan. 21      | 25.9                     | -2.7                   | 91                    |
| La Crosse                       | 42.0                            | -3.0                   | 91.3               | Aug. 2                 | -42.0 | Jan. 21      | 34.8                     | +2.6                   | 108                   |
| Davenport                       | 47.2                            | -2.1                   | 95.4               | July 31                | -24.5 | Jan. 15      | 40.5                     | +5.6                   | 116                   |
| Des Moines                      | 47.0                            | -1.9                   | 99.0               | July 31                | -27.4 | Jan. 15      | 31.2                     | -7.1                   | 82                    |
| Dubuque                         | 45.5                            | -1.9                   | 96.0               | Aug. 2                 | -30.5 | Jan. 16      | 33.3                     | -5.2                   | 86                    |
| Keokuk                          | 49.8                            | -1.7                   | 96.3               | July 31                | -23.0 | Jan. 15      | 35.8                     | -0.9                   | 97                    |
| Cairo                           | 56.7                            | -1.0                   | 97.0               | Aug. 2                 | -0.3  | Jan. 16      | 41.9                     | -2.1                   | 95                    |
| Springfield, Ill.               | 50.2                            | -2.9                   | 97.1               | July 31                | -17.0 | Jan. 15      | 40.8                     | -0.8                   | 98                    |
| Saint Louis                     | 54.6                            | -1.7                   | 97.9               | July 31                | -11.5 | Jan. 15      | 41.2                     | +2.6                   | 107                   |
| <i>Missouri Valley.</i>         |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Springfield, Mo.                | 54.9                            | .....                  | 99.0               | July 31                | -11.0 | Jan. 15      | 42.1                     | .....                  | .....                 |
| Leavenworth                     | 52.6                            | -0.9                   | 97.0               | July 30                | -21.1 | Jan. 15      | 47.2                     | +9.1                   | 124                   |
| Topeka                          | 51.8                            | .....                  | 99.8               | { Aug. 30<br>Sept. 3 } | -19.5 | Jan. 15      | 34.0                     | .....                  | .....                 |
| Omaha                           | 48.8                            | -0.8                   | 101.2              | July 30                | -25.2 | Jan. 15      | 24.2                     | -10.8                  | 69                    |
| Crete                           | 48.8                            | .....                  | 99.6               | July 12                | -28.2 | Jan. 15      | 23.3                     | .....                  | .....                 |
| Valentine                       | 43.3                            | .....                  | 102.9              | July 11                | -34.6 | Jan. 15      | 22.0                     | .....                  | .....                 |
| Fort Sully                      | 43.8                            | .....                  | 103.8              | July 11                | -31.7 | Jan. 16      | 14.8                     | -1.2                   | 92                    |
| Huron                           | 41.4                            | -1.6                   | 101.7              | July 11                | -36.0 | Jan. 15      | 17.0                     | -7.0                   | 71                    |
| Yankton                         | 45.6                            | -0.6                   | 101.8              | July 30                | -27.5 | Jan. 15      | 20.9                     | -7.4                   | 74                    |
| <i>Northern slope.</i>          |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Fort Assinaboine                | 41.1                            | +0.8                   | 102.0              | July 10                | -38.0 | Jan. 6, 21   | 14.0                     | -2.8                   | 83                    |
| Fort Custer                     | 43.5                            | -1.5                   | 102.9              | July 10                | -45.1 | Jan. 14      | 14.0                     | +0.9                   | 107                   |
| Fort Maginnis                   | 42.5                            | +0.4                   | 94.0               | July 10                | -39.2 | Jan. 13      | 25.7                     | +10.2                  | 166                   |
| Helena                          | 43.4                            | +0.4                   | 99.1               | July 10                | -41.0 | Jan. 15      | 10.1                     | -4.4                   | 69                    |
| Poplar River                    | 37.3                            | -1.2                   | 101.3              | June 18                | -56.8 | Jan. 9       | 13.4                     | +3.1                   | 130                   |
| Rapid City                      | 45.2                            | .....                  | 100.0              | July 10                | -29.7 | Jan. 14      | 22.8                     | .....                  | .....                 |
| Cheyenne                        | 45.6                            | +0.7                   | 97.2               | July 11                | -27.2 | Jan. 14      | 14.5                     | +3.1                   | 127                   |
| North Platte                    | 47.9                            | -1.0                   | 101.2              | July 5                 | -34.6 | Jan. 15      | 17.5                     | -1.7                   | 91                    |
| Fort McKinney                   | 44.4                            | .....                  | 95.0               | July 10                | -36.0 | Jan. 14      | 18.3                     | .....                  | .....                 |
| Fort Washakie                   | 42.4                            | .....                  | 99.0               | July 11                | -42.0 | Jan. 14, 15  | 13.3                     | .....                  | .....                 |
| <i>Middle slope.</i>            |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Colorado Springs                | 48.8                            | .....                  | 96.4               | July 12                | -23.0 | Jan. 15      | 9.1                      | .....                  | .....                 |
| Denver                          | 50.5                            | +0.7                   | 100.3              | July 11                | -20.3 | Jan. 15      | 9.5                      | -5.4                   | 63                    |
| Concordia                       | 51.8                            | -0.3                   | 103.0              | July 20                | -25.3 | Jan. 15      | 23.2                     | -3.6                   | 86                    |
| Dodge City                      | 54.1                            | +1.0                   | 103.5              | Aug. 14                | -18.0 | Jan. 15      | 22.9                     | +2.1                   | 111                   |
| Fort Elliott                    | 56.0                            | -1.0                   | 104.1              | Aug. 5                 | -14.2 | Jan. 15      | 16.5                     | -9.2                   | 64                    |
| <i>Southern slope.</i>          |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Fort Sill                       | 59.2                            | -1.4                   | 105.0              | Aug. 6                 | -7.2  | Jan. 15      | 35.7                     | +3.8                   | 112                   |
| Abitene                         | 62.8                            | -1.8                   | 103.0              | Aug. 7                 | -5.0  | Jan. 15      | 30.6                     | +1.9                   | 107                   |
| Fort Davis                      | 60.0                            | -0.7                   | 97.0               | Aug. 6                 | 0.0   | Jan. 15      | 18.1                     | -0.3                   | 93                    |
| Fort Stanton                    | 50.8                            | .....                  | 92.5               | June 28                | -3.0  | Jan. 15      | 18.0                     | +0.4                   | 103                   |
| <i>Southern plateau.</i>        |                                 |                        |                    |                        |       |              |                          |                        |                       |
| El Paso                         | 64.1                            | +0.1                   | 101.8              | Aug. 8                 | 12.8  | Jan. 15      | 9.8                      | -1.4                   | 87                    |
| Fort Grant                      | 61.1                            | -0.4                   | 97.6               | July 8                 | 19.2  | Jan. 8       | 14.2                     | -2.8                   | 84                    |
| Whipple Barracks                | 53.3                            | -0.8                   | 96.1               | July 15                | -12.0 | Jan. 8       | 18.5                     | +2.6                   | 116                   |
| Yuma                            | 72.3                            | +0.4                   | 113.7              | July 22                | 27.0  | Jan. 11      | 3.0                      | -0.1                   | 103                   |
| Keeler                          | 61.2                            | -0.3                   | 99.8               | Aug. 25                | 11.8  | Jan. 15      | 5.7                      | +2.2                   | 163                   |
| <i>Middle plateau.</i>          |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Winnemucca                      | 49.8                            | +1.0                   | 96.0               | July 20                | -28.0 | Jan. 15      | 4.9                      | -4.6                   | 52                    |
| Balt Lake City                  | 53.0                            | +1.9                   | 98.2               | Aug. 26                | -16.7 | Jan. 15      | 13.6                     | -3.3                   | 80                    |
| Montrose                        | 49.0                            | +0.1                   | 97.0               | July 5                 | -20.0 | Jan. 17      | 8.5                      | -1.3                   | 87                    |
| Carson City                     | 50.6                            | .....                  | 94.4               | July 16                | -9.6  | Jan. 16      | 6.6                      | .....                  | .....                 |
| Fort DuChesne                   | 45.4                            | .....                  | 101.7              | July 10                | -37.6 | Jan. 15      | 6.5                      | .....                  | .....                 |
| <i>Northern plateau.</i>        |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Boise City                      | 51.8                            | +1.2                   | 102.6              | Aug. 23                | -27.8 | Jan. 16      | 11.1                     | -2.6                   | 81                    |
| Spokane Falls                   | 49.0                            | +1.6                   | 101.8              | Aug. 22                | -30.5 | Jan. 16      | 17.7                     | -1.6                   | 92                    |
| Walla Walla                     | 54.2                            | .....                  | 102.4              | { Aug. 18<br>Aug. 21 } | -17.1 | Jan. 16      | 13.6                     | -4.7                   | 74                    |
| <i>N. Pacific coast region.</i> |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Fort Canby                      | 51.0                            | -0.2                   | 83.5               | Sept. 25               | 11.0  | Jan. 15      | 59.8                     | -1.0                   | 98                    |
| Olympia                         | 51.2                            | +1.4                   | 92.0               | July 17                | -1.8  | Jan. 15      | 45.5                     | -9.1                   | 83                    |
| Port Angeles                    | 47.0                            | +0.8                   | 79.0               | Aug. 30                | 6.3   | Jan. 14      | 28.2                     | -1.6                   | 95                    |
| Tatoosh Island                  | 49.5                            | +0.8                   | 71.7               | May 15                 | 14.0  | Jan. 13      | 83.7                     | -10.9                  | 88                    |
| Portland                        | 53.8                            | +0.8                   | 97.0               | July 17                | -2.0  | Jan. 15      | 35.8                     | -12.8                  | 75                    |
| Roseburgh                       | 54.8                            | +1.9                   | 100.0              | July 17                | -6.0  | Jan. 16      | 31.2                     | -4.1                   | 88                    |
| <i>M. Pacific coast region.</i> |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Eureka                          | 53.0                            | .....                  | 76.9               | Jan. 26                | 20.3  | Jan. 14      | 36.5                     | .....                  | .....                 |
| Red Bluff                       | 63.6                            | +1.5                   | 109.0              | July 20, 21            | 17.5  | Jan. 14      | 24.9                     | -0.9                   | 96                    |
| Sacramento                      | 61.4                            | +1.4                   | 107.5              | Aug. 24                | 19.0  | Jan. 14, 15  | 18.5                     | -3.2                   | 85                    |
| San Francisco                   | 57.3                            | +0.6                   | 93.4               | July 15                | 28.7  | Jan. 15      | 23.0                     | -0.5                   | 98                    |
| <i>S. Pacific coast region.</i> |                                 |                        |                    |                        |       |              |                          |                        |                       |
| Fresno                          | 64.4                            | .....                  | 111.1              | Aug. 24                | 19.6  | Jan. 16      | 8.8                      | .....                  | .....                 |
| Los Angeles                     | 63.2                            | +1.0                   | 99.0               | Apr. 13                | 30.9  | Jan. 10      | 21.0                     | +3.8                   | 122                   |
| San Diego                       | 61.0                            | +1.0                   | 93.0               | Apr. 12                | 33.0  | Jan. 8       | 11.6                     | +0.8                   | 107                   |

The following table shows the normal and current annual mean temperatures and rainfalls, departures, and extremes for past years, as reported by voluntary observers:

## Annual Summary for 1888.—Voluntary Stations.

| Stations.        | Temperature. |                   |                |            |               |       |              |       | Precipitation. |                   |                 |            |           |       |         |       |
|------------------|--------------|-------------------|----------------|------------|---------------|-------|--------------|-------|----------------|-------------------|-----------------|------------|-----------|-------|---------|-------|
|                  | Normal.      | Length of record. | Mean for 1888. | Departure. | Highest mean. |       | Lowest mean. |       | Normal.        | Length of record. | Total for 1888. | Departure. | Greatest. |       | Least.  |       |
|                  |              |                   |                |            | Degrees.      | Year. | Degrees.     | Year. |                |                   |                 |            | Amount.   | Year. | Amount. | Year. |
|                  |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| California.      |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Sacramento ...   | 60.3         | 30                | 57.7           | -2.6       | 62.8          | 1864  | 57.2         | 1880  | 19.00          | 38                | 21.06           | +2.06      | 32.19     | 1884  | 8.44    | 1877  |
| Georgia.         |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Forsyth .....    | 65.2         | 14                | 65.6           | +0.4       | 67.0          | 1880  | 62.6         | 1885  | 51.23          | 14                | 63.43           | +12.20     | 65.64     | 1882  | 33.85   | 1878  |
| Illinois.        |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Peoria .....     | 52.2         | 32                | 51.4           | -0.8       | 54.9          | 1878  | 49.5         | 1875  | 35.37          | 32                | 38.22           | +2.85      | 53.35     | 1858  | 23.57   | 1870  |
| Indiana.         |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Vevay .....      | 54.9         | 16                | 53.9           | -1.0       | 57.1          | 1882  | 51.8         | 1875  | 43.12          | 20                | 45.98           | +2.86      | 60.35     | 1883  | 33.31   | 1877  |
| Kansas.          |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Lawrence .....   | 52.9         | 20                | 52.3           | -0.6       | 55.3          | 1878  | 50.5         | 1869  | 34.66          | 20                | 44.17           | +9.51      | 44.18     | 1876  | 24.25   | 1886  |
| Maryland.        |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| McDonogh Lns.    | 51.9         | 12                | 51.4           | -0.5       | 53.1          | 1878  | 50.6         | 1883  | 37.39          | 12                | 45.90           | +8.51      | 45.90     | 1888  | 31.55   | 1879  |
| Massachusetts.   |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Amherst .....    | 46.8         | 52                | 44.0           | -2.8       | 49.8          | 1839  | 44.0         | 1888  | 43.84          | 50                | 58.04           | +14.20     | 58.82     | 1877  | 20.37   | 1884  |
| Somerset .....   | 50.0         | 14                | 48.6           | -1.4       | 50.8          | 1877  | 46.3         | 1875  | 45.25          | 14                | 53.51           | +8.26      | 53.51     | 1888  | 35.73   | 1885  |
| Westborough      | 48.3         | 13                | 48.0           | -0.3       | 50.1          | 1887  | 46.2         | 1875  | 43.14          | 12                | 53.50           | +10.36     | 58.04     | 1884  | 33.61   | 1883  |
| Nebraska.        |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| De Soto .....    | 47.8         | 21                | 47.4           | -0.4       | 51.0          | 1878  | 43.8         | 1875  | 32.61          | 16                | 32.27           | -0.34      | 47.49     | 1869  | 19.94   | 1887  |
| Genoa .....      | 40.8         | 12                | 46.5           | -0.3       | 49.3          | 1878  | 44.0         | 1884  | 27.68          | 12                | 29.30           | +1.62      | 34.90     | 1876  | 16.93   | 1879  |
| New Jersey.      |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Moorestown ..... | 51.4         | 14                | 50.2           | -1.2       | 52.7          | 1880  | 49.6         | 1885  | 41.75          | 9                 | 49.37           | +7.62      | 49.56     | 1882  | 36.03   | 1879  |
| New York.        |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Ardenia .....    | 49.6         | 19                | 48.7           | -0.9       | 52.6          | 1877  | 46.9         | 1856  | 40.68          | 12                | 50.91           | +10.23     | 50.91     | 1888  | 30.80   | 1880  |
| Cooperstown ..   | 43.8         | 34                | 42.3           | -1.5       | 46.9          | 1870  | 41.5         | 1875  | 37.51          | 34                | 38.45           | +0.94      | 48.12     | 1855  | 30.19   | 1879  |
| Palermo .....    | 44.1         | 28                | 42.6           | -1.5       | 47.8          | 1878  | 41.0         | 1885  | 37.30          | 31                | 34.78           | -5.52      | 51.30     | 1859  | 24.19   | 1884  |
| Ohio.            |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| College Hill ... | 53.0         | 62                | 53.8           | +0.8       | 56.9          | 1881  | 48.6         | 1831  | 47.91          | 21                | 62.56           | +14.65     | 72.08     | 1880  | 31.50   | 1877  |
| Oregon.          |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Eola .....       | 51.0         | 14                | 52.0           | +1.0       | 53.7          | 1874  | 48.8         | 1880  | 39.32          | 13                | 39.80           | +0.48      | 50.12     | 1877  | 30.71   | 1874  |
| Pennsylvania.    |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Blooming G've    | 46.3         | 20                | 47.2           | +0.9       | 49.8          | 1884  | 43.6         | 1868  | 40.75          | 20                | 59.10           | +18.35     | 59.10     | 1888  | 24.00   | 1876  |
| Tennessee.       |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Austin .....     | 59.6         | 16                | 59.5           | -0.1       | 61.4          | 1881  | 57.5         | 1883  | 52.37          | 12                | 42.58           | -9.79      | 73.37     | 1882  | 38.09   | 1885  |
| Vermont.         |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Lunenburg .....  | 41.6         | 40                | 41.3           | -0.3       | 44.8          | 1864  | 37.7         | 1875  | 39.58          | 40                | 43.58           | +4.00      | 60.91     | 1872  | 31.14   | 1880  |
| Stratford .....  | 43.6         | 15                | 41.9           | -1.7       | 45.2          | 1877  | 40.8         | 1875  | 39.08          | 14                | 47.85           | +8.77      | 48.45     | 1876  | 28.94   | 1882  |
| Virginia.        |              |                   |                |            |               |       |              |       |                |                   |                 |            |           |       |         |       |
| Bird's Nest....  | 58.3         | 20                | 55.9           | -2.4       | 61.3          | 1880  | 55.3         | 1872  | 44.51          | 19                | 48.06           | -3.55      | 56.30     | 1875  | 33.37   | 1870  |

**Minnesota.**—As compared with the three preceding years there was a deficiency of about 2° in temperature, and an excess of about three inches in precipitation. The latest frost of spring occurred at Saint Vincent, June 6th, and the first frost of fall was noted at Saint Vincent and Grand Forks, Dak., August 9th. This early frost damaged the wheat and other crops in northern Minnesota and Dakota.—*Report of the Minnesota State Weather Service.*

**Nebraska.**—The temperature was nearly normal, but the extremes in temperature were unusually great. The precipitation averaged somewhat below the normal, but had a wide range, varying from about fifteen inches in the southwestern part of the state to over thirty-three inches in the southeastern.—*Report of the Nebraska State Weather Service.*

**California.**—Lewis Creek, Tulare Co.: January very frosty and cold. All the lemons on the place were killed. April was the driest known for years. In November and December there was an unusual amount of fog.—*Report of voluntary observer.*

Oroville, Butte Co.: the cold-wave that passed over the state in January was the longest continuous spell of cold weather and marked the lowest temperatures of any period since 1849. It began on the 4th, and the temperature was below 32° for fourteen days with but one exception. Commencing on the 19th of August and ending September 12th, was the longest continuous spell of hot weather I have ever experienced.—*Report of voluntary observer.*

**Florida.**—Manatee, Manatee Co.: light frost January 19th and 30th, and general frost November 26th, December 21st and 22d, none of which were damaging.—*Report of voluntary observer.*

**Massachusetts.**—Blue Hill, Norfolk Co.: the noteworthy phenomena during the year were the exceptionally cold January (7° below normal), the very cool July and October, the heavy rainfall during the autumn, and the severe and destructive storms of March 11–13th and November 25–28th.—*Report of voluntary observer.*

**New Hampshire.**—Concord: the total precipitation of the year exceeded the average of the preceding thirty-two years by 14.12 inches, and has only been exceeded once, in 1863.—*Report of voluntary observer.*

#### OCEAN FOG DURING 1888.

The following table shows the number of days in each month for which fog was reported on the north Atlantic Ocean west of the fortieth meridian during 1888:

| Month.          | Between W.<br>40° and 55°. | Between W.<br>55° and 65°. | West of 65°. |
|-----------------|----------------------------|----------------------------|--------------|
| January .....   | 8                          | 2                          | 7            |
| February .....  | 15                         | 6                          | 11           |
| March .....     | 25                         | 6                          | 16           |
| April .....     | 17                         | 10                         | 13           |
| May .....       | 23                         | 12                         | 21           |
| June .....      | 26                         | 13                         | 18           |
| July .....      | 25                         | 13                         | 13           |
| August .....    | 16                         | 13                         | 9            |
| September ..... | 11                         | 2                          | 11           |
| October .....   | 6                          | 7                          | 5            |
| November .....  | 9                          | 4                          | 7            |
| December .....  |                            |                            | 6            |
| Totals .....    | 199                        | 95                         | 124          |

From the above it will be seen that in the vicinity of the Banks of Newfoundland fog was most frequently reported during the summer months, the greatest number of foggy days in any month (28) being noted in July. From this time there was a gradual decrease in fog-frequency until December. In the vicinity and to the southward of Sable Island and Sable Island Bank the period of greatest fog-frequency corresponded with that of the Grand Banks, although the aggregate number of foggy days during the year was more than 50 per cent. less. Over and near George's and Nantucket Shoals, and off the coast of the United States to the southward, the month of greatest fog-frequency was May, when its occurrence was reported on twenty-one days, from which time there was a gradual monthly decrease in the number of foggy days until December.

The more frequent occurrence of fog near Newfoundland during the spring and summer months is attributed to the presence in that locality during those seasons of extensive fields of Arctic ice which commence to drift southward in the Labrador current during the early spring months. As the season advances the ice massed along the Labrador and more northern coasts breaks away in larger quantities, and during the late spring and early summer months there is an immense accumulation of field ice and icebergs off Newfoundland and over the Grand Banks. In succeeding numbers of the REVIEW during the past two years the subject of ocean fog has been made a feature. It has been shown that its development near New-

foundland is incidental to a shift of wind to southerly or southeasterly with the approach or passage of areas of low barometric pressure, and that the more frequent and denser development of fog during the ice season is apparently due to the more marked differences in the temperature of air drawn by southerly winds from over the ocean to the southward and the Gulf Stream and the air which immediately overlies the cold surface of the ice fields. The gradual decrease in the quantity of ice in that region is attended by a diminution in fog-frequency until the months of November, December, and January, when the southward movement of Arctic ice has ceased, and the occasional development of fog is apparently dependent upon the contrasts in temperature occasioned by the warm Gulf Stream and the cold Arctic current which meet in that locality.

Between the fifty-fifth and sixty-fifth meridians the season of greatest fog-frequency extended from May to September, inclusive; it occurred on the greatest number of days (thirteen) in July and August, respectively, and upon the least number of days (two) in January. In this region fog is generally encountered with east to south winds occasioned by the approach or passage to the northward of areas of low barometric pressure, and its development apparently depends largely upon the contrasts in temperature which exist between the warm, moist air drawn from over the Gulf Stream and that which overlies Sable Island Bank, where the deep-flowing cold waters of the Arctic current are forced to the surface. To the westward of the sixty-fifth meridian the season of greatest fog-frequency was somewhat earlier than in the other regions referred to, and extended from April to July, inclusive; the greatest number of foggy days (twenty-one) being shown in May, and the least (three) in December. In this, as in the fog districts to the eastward, there is an apparent relation between the development of fog and the meeting of masses of warm, vapor-laden air drawn from over the Gulf Stream by the cyclonic circulation of winds in the eastern quadrants of areas of low pressure which advance from the continent north of the fortieth parallel, and the colder air which overlies the waters on George's and Nantucket shoals, where, as over Sable Island Bank, is found a similar forcing to the surface of the cold, deep-flowing waters of the Arctic current. If, as it appears, fog-development is occasioned by the meeting of warm, humid air from the Gulf Stream, and cold air overlying the ice fields, and the banks and shoals of the Arctic current, and, in instances, the cold air flowing from the continent, it would seem to follow that the months in which these contrasts in temperature were more marked would be the months of greatest fog-frequency. In the case of the fog of the Newfoundland Banks, it has been shown that these differences are more marked during the ice season, and that this season corresponds with that of the greatest fog-frequency. As regards the more westerly districts, it is assumed that while the absolute differences in temperature during the spring and summer months are not equal to those which exist in winter, the greater capacity of the sea air for moisture, and the fact that it is more nearly saturated in the summer season, renders it more susceptible to the influence of cooler air, as regards the precipitation of its aqueous vapor, and the contrasts in temperature with the air over the cold coast current, or its banks and shoals, need not necessarily be so great in order to cause a condensation of fog particles.

Since September, 1886, there have been printed in the MONTHLY WEATHER REVIEW from time to time special articles giving general conclusions in connection with the subject, and intimating the practicability of making forecasts of the probable dates on which fog would occur along the trans-Atlantic steamship routes and off the Maritime States and Provinces. The importance now attached to this work is indicated by the following extract taken from "Nautical Monographs, No. 5," prepared by Mr. Everett Hayden, in charge of the division of marine meteorology, Hydrographic Office, United States Navy, and issued in January, 1889: "Scientific research and practical inventive genius, advancing hand in hand for the benefit

of mankind, have discovered not only the laws governing the formation of the dense banks of fog that have made the Grand Banks dreaded by navigators, but also the means by which certain facts may be observed, telegraphed, charted, and studied a thousand miles away, and the occurrence of fog predicted with almost unfailing accuracy, even whilst the very elements themselves are only preparing for its formation. By means of such predictions the safety of navigation along the greatest highway of ocean traffic in the world would be vastly increased—routes traversed yearly, at almost railroad speed, by vessels intrusted with more than a million of lives and property of an aggregate value of fully a billion dollars."

As the principal fog-belts of the north Atlantic extend along or near the trans-Atlantic steamship tracks, and reports have been contributed monthly by hundreds of shipmasters, there is now available a large amount of data bearing upon this subject, from which an exhaustive study of the more detailed meteorological conditions attending fog formation over the ocean could be made. It has been possible thus far to determine the general meteorological features that have preceded fog along the steamship routes west of the fortieth meridian, and to deduce certain conclusions as to the relations which appear to exist between the storms which advance from the American continent and the development of fog in those regions. While these general conclusions seem to admit of the successful forecasting of fog, they do not satisfactorily explain those exceptional cases wherein the conditions apparently favor fog development, and no fog occurs, and those in which fog does occur in the absence of well-defined favorable conditions. While these instances are not of common occurrence, and would not probably seriously reduce the percentage of verifications of predictions based upon the general laws of fog formation, they constitute a feature, which, while apparently due to insufficient or excessive differences in temperature or humidity, as applicable to the one or the other of the instances cited, require, for a more satisfactory solution, a more detailed investigation of the subject than has heretofore been afforded it.

*Precipitation (in inches and hundredths) furnished (with notes) by Thomas R. Rodman, voluntary observer, New Bedford, Mass.*

NOTE.—Observations were commenced by Mr. Samuel Rodman in October, 1813, at New Bedford, Mass. The station was located at the corner of Water and William streets about 200 feet from, and at an estimated elevation of the gauge of about 15 feet above, the tide water of the Acushnet River.

On the 24th of January, 1820, the location of his meteorological observations was changed to his residence on Middle street, just west of the projection of Water street, about 400 feet north of the place of his first observations, about 100 feet from, and about 10 feet above, the same tide water.

On the 19th of January, 1828, the location of his observations was again changed to his new residence, corner of Spring and County streets, about one-half mile southwest of the Middle street house, about three-eighths of a mile from, and about 100 feet above, the same tide water. Here the record has been kept continuously since.

In this last locality the position of the gauge was about 50 feet south of the house.

In 1880 the gauges were removed to a point about 25 feet to the northeast, and a little later they were removed about 25 feet farther in the same direction; and here, since some date in 1882, as I estimate, they have stood until the present time.

The elevation of the ground on which they now stand is about 92 feet above tide water, about 50 feet southeast of the three story house, about 50 feet north of Grace Church, and about 15 feet southwest of the "L" of the house of William N. Church. The tops of the gauges are 31 inches above the ground.

Care has been taken to remove the gauges so far as practicable, from all disturbing influences.

The first gauge used by my father was made of tin and I still record the measurements of such a one, though not the identical instrument used in his first observations, as I found the following note made January, 1859, when he began to use other gauges: "The same instrument has not been used the whole of that early period (1813—1859) several having been stolen or destroyed." The present tin cone, which I judge is constructed upon the lines of its predecessors, has an internal depth of 14 inches, which includes a section of a cylinder 2 inches deep. Its diameter at widest part is 6 inches.

I do not know whence or how my father arrived at those proportions, but he became dissatisfied subsequently with the accuracy of the tin gauge and in January, 1859, procured of Mr. Edward S. Ritchie, a mathematical instrument maker of Boston, and of high repute in his profession, as elsewhere, another gauge made of copper, but designated as the "Brass Cone." This cone is of the same measurements as the tin cone, except that its greatest diameter is

5½ inches. Within a few years the Brass or Ritchie Cone was tested by Mr. Lawrence Roch of the Blue Hill Observatory, Mass., and found to be accurate. Its correctness has also been established by Mr. Robert P. Coggeshall, superintendent of the New Bedford Water-Works, in behalf of the New England Meteorological Society.

About the same time my father received from the Smithsonian Institute, Washington, another gauge.

Since or beginning with January, 1859, the record of the three gauges has been kept, and the following results were reached by my father after seven years comparison.

There was a remarkable almost absolute correspondence between the Brass Cone and the Smithsonian, and it was found that their registry was about one eighth in excess of that of the tin cone.

In making up the table of rainfall for seventy-five years, which I sent you, the addition of one-eighth has been made for the period from 1814 to 1859, inclusive, when the tin cone only was used.

Practically speaking, all the records of the rainfall from October, 1818, to July 28, 1876, inclusive, were made by my father. I have taken up the work where he left it, and almost without assistance have carried it on since. I should state that the table gives the record of the Brass or Ritchie cone.

I must here record my obligations to Mr. Coggeshall, aforesaid, under whose faithful and intelligent supervision the tables were prepared.

| Year.   | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Annual. |
|---------|----------|-----------|--------|--------|------|-------|-------|---------|------------|----------|-----------|-----------|---------|
| 1814... | 1.42     | 8.30      | 2.16   | 5.46   | 4.23 | 2.27  | 0.99  | 6.44    | 3.06       | 1.73     | 5.37      | 1.65      | 43.08   |
| 1815... | 4.55     | 3.32      | 5.02   | 4.66   | 4.11 | 2.22  | 1.96  | 4.36    | 2.51       | 1.47     | 3.45      | 3.15      | 40.78   |
| 1816... | 2.12     | 6.82      | 2.47   | 5.50   | 6.15 | 2.33  | 1.01  | 1.46    | 6.05       | 3.96     | 5.56      | 0.70      | 44.13   |
| 1817... | 3.96     | 5.26      | 1.77   | 2.60   | 1.19 | 7.00  | 0.88  | 3.21    | 4.09       | 1.19     | 6.64      | 5.54      | 43.33   |
| 1818... | 3.31     | 0.91      | 3.31   | 3.94   | 6.79 | 3.51  | 3.32  | 1.66    | 5.52       | 2.84     | 3.35      | 2.31      | 40.77   |
| 1819... | 1.25     | 2.54      | 7.30   | 3.31   | 2.06 | 3.32  | 1.57  | 6.00    | 4.01       | 3.84     | 1.92      | 1.74      | 39.66   |
| 1820... | 1.46     | 5.02      | 4.44   | 1.23   | 5.41 | 0.46  | 3.71  | 4.38    | 2.01       | 6.22     | 3.75      | 2.23      | 41.32   |
| 1821... | 2.32     | 5.96      | 2.52   | 6.09   | 5.42 | 3.78  | 2.41  | 2.23    | 4.11       | 4.96     | 2.94      | 2.90      | 45.64   |
| 1822... | 3.29     | 3.70      | 3.31   | 4.76   | 0.58 | 2.58  | 5.14  | 3.51    | 6.05       | 2.97     | 3.62      | 2.27      | 41.78   |
| 1823... | 4.84     | 5.00      | 8.43   | 1.83   | 7.67 | 3.20  | 4.63  | 3.90    | 2.88       | 5.06     | 3.51      | 9.74      | 59.80   |
| 1824... | 3.84     | 5.32      | 3.61   | 5.74   | 2.68 | 3.14  | 2.44  | 6.21    | 4.08       | 2.55     | 3.54      | 3.39      | 47.34   |
| 1825... | 2.80     | 2.21      | 6.06   | 1.42   | 2.11 | 3.71  | 2.06  | 3.52    | 1.68       | 2.78     | 1.81      | 7.93      | 38.09   |
| 1826... | 2.19     | 3.85      | 4.08   | 2.92   | 0.73 | 2.11  | 2.44  | 18.72   | 1.44       | 7.47     | 4.50      | 4.32      | 54.77   |
| 1827... | 3.14     | 3.99      | 4.88   | 3.46   | 6.94 | 4.42  | 4.36  | 7.63    | 5.65       | 6.68     | 7.42      | 3.33      | 62.90   |
| 1828... | 3.02     | 3.25      | 4.31   | 3.48   | 3.91 | 4.04  | 3.02  | 1.15    | 3.63       | 3.62     | 5.16      | 0.45      | 39.04   |
| 1829... | 9.06     | 5.76      | 7.03   | 4.79   | 8.59 | 2.92  | 3.40  | 7.53    | 3.49       | 3.53     | 7.18      | 2.13      | 65.41   |
| 1830... | 4.20     | 3.07      | 4.77   | 2.25   | 6.63 | 3.71  | 12.00 | 6.22    | 5.20       | 3.54     | 6.18      | 6.89      | 64.66   |
| 1831... | 7.47     | 3.53      | 5.24   | 7.38   | 4.45 | 3.52  | 7.26  | 3.32    | 5.86       | 6.04     | 3.68      | 3.43      | 61.18   |
| 1832... | 3.98     | 5.36      | 3.02   | 4.41   | 6.55 | 0.41  | 1.69  | 8.30    | 3.00       | 2.64     | 4.43      | 6.52      | 49.31   |
| 1833... | 3.91     | 2.37      | 1.92   | 2.31   | 4.14 | 4.25  | 1.38  | 2.57    | 1.88       | 5.70     | 5.51      | 6.68      | 42.62   |
| 1834... | 2.76     | 1.61      | 1.95   | 2.94   | 4.74 | 7.30  | 3.42  | 1.81    | 5.63       | 5.25     | 4.23      | 3.48      | 45.12   |
| 1835... | 3.35     | 1.80      | 6.52   | 6.84   | 2.05 | 2.52  | 1.56  | 10.16   | 0.90       | 2.99     | 2.97      | 4.95      | 47.21   |
| 1836... | 9.53     | 4.62      | 3.78   | 2.78   | 1.76 | 4.93  | 1.90  | 1.12    | 1.28       | 2.58     | 4.53      | 4.02      | 42.83   |
| 1837... | 3.69     | 3.75      | 4.47   | 3.33   | 6.47 | 4.41  | 2.15  | 4.37    | 0.51       | 1.34     | 1.50      | 3.05      | 39.07   |
| 1838... | 3.00     | 2.41      | 2.90   | 2.15   | 3.02 | 2.84  | 1.55  | 2.99    | 6.71       | 5.38     | 4.36      | 0.97      | 38.28   |
| 1839... | 0.77     | 2.71      | 2.44   | 4.83   | 4.96 | 2.51  | 2.76  | 5.69    | 3.38       | 5.86     | 2.01      | 6.26      | 44.38   |
| 1840... | 3.25     | 2.68      | 3.99   | 4.56   | 5.82 | 3.69  | 2.14  | 2.88    | 3.07       | 6.93     | 7.52      | 3.06      | 49.59   |
| 1841... | 5.57     | 1.75      | 4.06   | 9.27   | 1.66 | 1.44  | 3.05  | 5.05    | 2.90       | 4.70     | 5.09      | 5.34      | 50.60   |
| 1842... | 2.47     | 4.34      | 2.89   | 3.77   | 3.17 | 7.40  | 1.34  | 1.97    | 2.00       | 0.86     | 3.06      | 5.79      | 39.06   |
| 1843... | 3.94     | 4.18      | 4.02   | 6.19   | 1.39 | 1.45  | 3.31  | 7.13    | 1.77       | 6.86     | 5.09      | 5.34      | 50.67   |
| 1844... | 4.19     | 2.18      | 6.65   | 1.79   | 2.60 | 0.90  | 3.08  | 2.49    | 4.15       | 4.56     | 4.01      | 4.13      | 40.73   |
| 1845... | 4.10     | 3.00      | 3.04   | 1.87   | 3.79 | 2.34  | 3.09  | 3.37    | 4.49       | 4.29     | 9.72      | 4.90      | 48.06   |
| 1846... | 3.09     | 2.57      | 1.74   | 1.20   | 6.40 | 0.99  | 2.61  | 3.07    | 2.48       | 1.68     | 3.80      | 4.88      | 34.51   |
| 1847... | 3.33     | 4.57      | 3.25   | 1.66   | 2.64 | 6.46  | 2.41  | 7.15    | 7.20       | 0.62     | 1.52      | 5.10      | 45.91   |
| 1848... | 3.75     | 4.22      | 2.89   | 1.46   | 3.88 | 2.99  | 4.04  | 1.16    | 1.89       | 5.43     | 3.30      | 5.73      | 40.74   |
| 1849... | 0.88     | 2.07      | 5.70   | 2.23   | 2.43 | 1.59  | 1.22  | 4.88    | 1.24       | 5.71     | 5.15      | 3.32      | 36.42   |
| 1850... | 5.87     | 2.22      | 6.05   | 9.25   | 4.49 | 1.23  | 2.26  | 6.29    | 12.06      | 2.62     | 2.82      | 7.51      | 62.67   |
| 1851... | 2.42     | 6.20      | 3.27   | 4.84   | 4.78 | 1.18  | 9.22  | 3.49    | 3.75       | 5.37     | 4.76      | 2.51      | 51.61   |
| 1852... | 3.91     | 3.57      | 5.50   | 7.86   | 3.50 | 1.71  | 2.55  | 5.49    | 2.01       | 2.03     | 3.66      | 4.35      | 46.14   |
| 1853... | 1.69     | 4.67      | 1.28   | 3.92   | 4.36 | 0.92  | 3.95  | 2.95    | 3.84       | 3.52     | 3.92      | 4.45      | 39.47   |
| 1854... | 1.99     | 5.07      | 2.15   | 6.83   | 3.50 | 3.02  | 7.44  | 0.24    | 8.37       | 1.48     | 9.66      | 3.40      | 53.82   |
| 1855... | 4.72     | 2.62      | 1.95   | 4.24   | 3.64 | 1.84  | 4.79  | 1.42    | 0.62       | 4.66     | 4.82      | 5.68      | 41.00   |
| 1856... | 5.18     | 1.27      | 1.64   | 3.20   | 3.96 | 2.12  | 3.32  | 2.81    | 4.56       | 1.89     | 3.26      | 3.88      | 37.00   |
| 1857... | 6.20     | 1.84      | 2.52   | 5.90   | 3.69 | 2.30  | 4.62  | 3.94    | 2.32       | 2.64     | 1.84      | 5.49      | 43.30   |
| 1858... | 2.46     | 1.28      | 2.28   | 4.39   | 2.02 | 5.16  | 6.75  | 5.05    | 3.02       | 3.20     | 3.44      | 4.58      | 44.03   |
| 1859... | 8.53     | 4.40      | 6.64   | 3.44   | 5.14 | 6.16  | 0.96  | 4.02    | 3.64       | 2.07     | 2.10      | 4.34      | 51.43   |
| 1860... | 1.37     | 3.50      | 2.82   | 2.86   | 2.80 | 3.26  | 2.96  | 5.00    | 5.24       | 1.82     | 3.44      | 4.05      | 39.73   |
| 1861... | 4.19     | 3.28      | 4.06   | 5.44   | 4.42 | 3.12  | 1.70  | 5.00    | 3.50       | 4.30     | 4.58      | 2.90      | 46.46   |
| 1862... | 3.27     | 3.88      | 2.80   | 1.66   | 2.86 | 8.05  | 3.06  | 1.20    | 3.98       | 5.62     | 4.47      | 2.46      | 43.32   |
| 1863... | 2.75     | 4.16      | 4.26   | 4.34   | 3.52 | 2.49  | 4.26  | 2.51    | 2.50       | 1.90     | 7.03      | 5.37      | 45.10   |
| 1864... | 4.35     | 1.51      | 5.22   | 3.10   | 2.93 | 1.08  | 1.50  | 7.68    | 2.28       | 2.35     | 4.18      | 4.48      | 40.96   |
| 1865... | 5.51     | 3.92      | 4.90   | 3.24   | 6.36 | 1.66  | 1.55  | 1.21    | 0.26       | 4.93     | 4.47      | 4.40      | 46.01   |
| 1866... | 2.30     | 4.54      | 3.70   | 2.06   | 4.15 | 4.18  | 1.86  | 3.60    | 5.32       | 2.64     | 2.65      | 3.31      | 40.30   |
| 1867... | 2.84     | 5.08      | 5.58   | 3.18   | 3.85 | 2.36  | 6.03  | 5.70    | 2.44       | 3.96     | 1.99      | 4.10      | 47.11   |
| 1868... | 6.17     | 2.43      | 4.04   | 5.96   | 9.42 | 4.51  | 3.78  | 4.50    | 5.91       | 1.68     | 2.98      | 2.34      | 56.32   |
| 1869... | 3.97     | 5.34      | 6.22   | 1.42   | 5.92 | 4.45  | 1.62  | 2.76    | 2.62       | 6.75     | 2.30      | 6.56      | 49.94   |
| 1870... | 6.20     | 4.55      | 3.46   | 6.20   | 3.50 | 3.62  | 3.05  | 1.69    | 1.28       | 6.64     | 3.28      | 3.70      | 47.66   |
| 1871... | 3.26     | 3.28      | 4.86   | 3.93   | 2.68 | 5.39  | 1.92  | 6.35    | 2.24       | 6.38     | 3.58      | 2.34      | 49.60   |
| 1872... | 2.64     | 2.42      | 5.33   | 2.27   | 3.51 | 2.68  | 6.40  | 4.04    | 4.58       | 5.79     | 3.58      | 4.42      | 47.66   |
| 1873... | 7.44     | 4.93      | 5.33   | 2.27   | 3.51 | 2.68  | 6.40  | 4.04    | 4.58       | 5.79     | 3.58      | 4.42      | 47.66   |
| 1874... | 4.27     | 4.27      | 2.89   | 3.08   | 4.95 | 1.44  | 1.22  | 4.16    | 3.17       | 5.34     | 4.99      | 3.34      | 49.34   |
| 1875... | 3.78     | 3.67      | 7.86   | 4.04   | 4.20 | 4.98  | 4.00  | 4.60    | 2.38       | 4.96     | 4.86      | 0.94      | 48.33   |
| 1876... | 1.02     | 4.85      | 5.54   | 3.85   | 1.68 | 0.73  | 3.86  | 1.23    | 4.40       | 1.52     | 8.42      | 5.09      | 42.18   |
| 1877... | 3.06     | 1.79      | 9.42   | 3.13   | 2.92 | 2.30  | 4.93  | 3.39    | 0.83       | 7.06     | 6.00      | 0.95      | 47.04   |
| 1878... | 5.97     | 4.05      | 4.77   | 4.91   | 2.91 | 2.97  | 2.36  | 5.38    | 1.04       | 5.93     | 5.74      | 4.49      | 50.56   |
| 1879... | 3.42     | 3.00      | 5.66   | 5.12   | 1.83 | 2.78  | 3.59  | 4.37    | 3.18       | 1.19     | 3.55      | 4.72      | 42.31   |
| 1880... | 2.06     | 2.97      | 4.85   | 3.49   | 1.37 | 1.96  | 6.59  | 5.62    | 1.68       | 3.11     | 2.44      | 3.92      | 40.07   |
| 1881... | 4.14     | 5.83      | 4.74   | 1.79   | 2.39 | 5.14  | 1.65  | 0.79    | 2.39       | 1.52     | 5.78      | 2.04      | 39.10   |
| 1882... | 4.14     | 6.23      | 2.48   | 4.06   | 4.74 | 1.70  | 1.52  | 0.80    | 6.26       | 4.00     | 1.91      | 3.45      | 41.31   |
| 1883... | 4.73     | 4.67      | 2.08   | 2.93   | 3.60 | 1.46  | 6.92  | 0.85    | 2.74       | 6.36     | 3.28      | 3.89      | 43.58   |
| 1884... | 4.85     | 5.72      | 5.29   | 5.17   | 3.33 | 5.38  | 4.80  | 8.49    | 0.98       | 1.63     | 3.55      | 5.80      | 54.99   |
| 1885... | 5.20     | 2.76      | 1.49   | 2.66   | 3.15 | 4.06  | 1.17  | 4.23    | 1.85       | 4.04     | 3.16      | 3.04      | 36.81   |
| 1886... | 6.77     | 7.05      | 5.09   | 2.19   | 4.39 | 1.99  | 2.69  | 2.76    | 1.15       | 4.23     | 3.76      | 6.78      | 40.85   |
| 1887... | 6.02     | 6.25      | 5.83   | 5.45   | 2.24 | 3.15  | 3.61  | 6.68    | 1.71       | 3.95     | 2.60      | 4.28      | 51.77   |
| 1888... | 4.38     | 2.63      | 5.66   | 2.42   | 5.57 | 1.45  | 5.17  | 4.89    | 9.52       | 2.66     | 7.39      | 3.33      | 55.07   |
| Means.  | 3.90     | 3.82      | 4.17   | 3.96   | 3.95 | 3.15  | 3.36  | 4.28    | 3.48       | 3.93     | 4.31      | 4.11      | 46.31   |